

WE CLAIM

1. A method of epoxidizing an unsaturated compound having a carbon-to-carbon double bond to form an oxirane ring across the double bond comprising:

adding to said unsaturated compound (a) an organic acid capable of being oxidized to form a peracid; (b) an oxidizing agent selected from hydrogen peroxide or acetaldehyde monoperacetate, or a combination thereof; and (c) with or without an acid catalyst selected from a mineral acid or styrene sulfonic acid, or a combination thereof to form a reactant mixture; and

forming the reactant mixture in a film against a wall of a thin-film reactor that is at a temperature sufficient to form a peracid from the organic acid, and contacting the film of reactant mixture against the film reactor wall for a time sufficient for reaction of a portion of the peracid with the unsaturated compound to form an oxirane ring across a double bond of the unsaturated compound.

2. A method in accordance with claim 1, wherein the method is a continuous method such that the reactant mixture is continuously fed to the thin-film reactor and the epoxidized unsaturated compound is continuously recovered from the thin-film reactor while maintaining the thin-film reactor under isothermal conditions.

3. A method in accordance with claim 2, further including the step of recovering (a) and (b) and water from the thin-film reactor for recycle of (a) and (b) to the thin-film reactor together with feeding to the thin-film reactor additional unsaturated compound and additional (a), (b), and (c) in amounts sufficient for epoxidizing the additional unsaturated compound.

4. A method in accordance with claim 1, wherein the film of reactants is heated or cooled to a temperature in the range of about 65°F to about 150°F.

5. A method in accordance with claim 1, wherein the molar ratio of unsaturated compound to peroxide are in the range of 0.5 - 1.0 to 1.0 - 0.05.

6. A method in accordance with claim 2, further including the step of continuously forcing the reactant mixture against said heated reactor wall, by centrifugal force, for efficient heating, in film form, of the reactant mixture.

7. A method in accordance with claim 2, further including the additional step of recycling non-epoxidized and/or incompletely epoxidized unsaturated compound to the film reactor for epoxidation of at least a portion of the non-epoxidized and/or incompletely epoxidized unsaturated compound.

8. A method in accordance with claim 1, wherein the feed rates of unsaturated compound, and peroxide can be varied to affect production rates and product quality.

9. A method in accordance with claim 8, wherein the residence time in the film reactor is in the range of 1 second to 300 seconds.

10. A method in accordance with claim 9, wherein the residence time in the film reactor is in the range of 3 seconds to 30 seconds.

11. A method of epoxidizing an unsaturated compound having a carbon-to-carbon double bond to form an oxirane ring across the double bond comprising:

adding a peracid and said unsaturated compound to a thin-film reactor to form a reactant mixture in a film against a wall of the thin-film reactor that is at a temperature sufficient for reaction of a portion of the peracid with the unsaturated compound to form an oxirane ring across a double bond of the unsaturated compound.

12. A method in accordance with claim 11, wherein the method is a continuous method such that the reactant mixture is continuously fed to the thin-film reactor and the epoxidized unsaturated compound is continuously recovered from the thin-film reactor while maintaining the thin-film reactor under isothermal conditions.

13. A method in accordance with claim 12, further including the step of recovering excess acid from the thin-film reactor for peracid manufacture and feeding the manufactured peracid to the thin-film reactor together with feeding to the thin-film reactor additional unsaturated compound, and additional peracid in an amount sufficient for epoxidizing the additional unsaturated compound.

14. A method in accordance with claim 13, wherein the film of reactants is heated or cooled to a temperature in the range of about 65°F to about 150°F.

15. A method in accordance with claim 11, wherein the molar ratio of unsaturated compound to peracid is in the range of 0.5 - 1.0 to 1.0 - 0.05.

16. A method in accordance with claim 11, further including the step of contacting an organic acid, and an oxidizing agent for the organic acid, with an ion-exchange resin to form a peracid by oxidation of the organic acid and feeding the peracid to the thin-film reactor for reaction with the unsaturated compound.

17. A method in accordance with claim 12, further including the step of continuously forcing the reactant mixture against said heated reactor wall, by centrifugal force, for efficient heating, in film form, of the reactant mixture.

18. A method in accordance with claim 12, further including the additional step of recycling non-epoxidized and/or incompletely epoxidized unsaturated compound to the thin-film reactor for epoxidation of at least a portion of the non-epoxidized and/or incompletely epoxidized unsaturated compound.

19. A method in accordance with claim 11, wherein the residence time in the thin-film reactor is in the range of 1 second to 300 seconds.

20. A method in accordance with claim 19, wherein the residence time in the film reactor is in the range of 3 seconds to 30 seconds.